THE SURGERY OF GASTRIC AND DUODENAL ULCER

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(Delivered before The New York Academy of Medicine, November 4, 1926)

First let us take a hasty glance over our subject touching the high points so to speak, before undertaking a more detailed consideration of those particular phases of it that more intimately concern us as surgeons.

The first description of the pathology of gastric ulcer was published by Baillie in 1793, but inasmuch as it was not accompanied by any clinical data, it had little effect in stimulating interest in the condition. Abercrombie, in 1824, described much of the symptomatology of gastric ulcer, but did not differentiate simple ulcer from ulcerated carcinoma. The credit of having first recognized the difference between ulcer of the stomach, carcinoma and ordinary gastritis belongs to Cruveilhier, who, between 1829 and 1835, published accurate descriptions of the anatomy, the clinical course and the treatment of gastric ulcer. Following Cruveilhier, Rokitansky, in 1839, described the anatomy of the condition, basing his description on 79 cases collected and studied by him. At the time that Dr. Welch wrote his masterly account of ''Simple Ulcer of the Stomach'' for Pepper's System of Medicine, published in 1885, he found medical literature abounding in articles upon this disease. Some of the more important contributions were those of Gatch on symptomatology and diagnosis, Virchow on etiology, the statistical analyses of Brinton, and the articles of Ziemssen, Leube, Budd, Chambers, Habershon, Fenwick and Fox. Of the enormous number of articles dealing with this condition and published since 1885, very few have advanced materially our knowledge of the pathology of the condition. Due largely to their divergence from commonly accepted ideas, the publications of Wilson and MacCarty have directed attention to the development of carcinoma in simple ulcers. The theory of bacterial origin has received renewed support from the work of Rosenow. The development of surgical technique has increased greatly the extent of surgical treatment, and also has been the basis for the great amount of work on the experimental production and treatment of this condition.

Following their experiments on dogs, Gussenbauer and von Winiwarter, in 1876, had proposed pylorectomy. These experiments of Gussenbauer and von Winiwarten are generally supposed to have been the first recorded operations upon the stomachs of dogs, but such is not the case. Merrem, of Giessen, in a monograph published in 1810 writes as follows:*

"Extirpation of the pylorus. A certain famous professor, highly respected and renowned among the medical profession in Philadelphia, was greatly concerned by the premature death of Dr. Middleton, whose death was caused by the hardening and narrowing of the lower orifice of the stomach. He therefore concentrated his attention on the most effective remedy for this very dangerous malady. The terrible sufferings of his beloved friend could not be removed nor even relieved, although the most approved remedies of the time were used. Nothing therefore was left other than to remove the cause of the disease, that is, to extirpate the pylorus. This operation seemed involved in such serious danger, that at the time his friend would not perform it. Two years before he had had experiments made on several dogs, some of them in perfect health, one a puppy, and they all terminated fatally. (I attribute the blame for this to the difficulty of the operation and to lack of surgical skill.) He used the cruciform section, the perpendicular part of it extending from the xiphoid cartilage of the sternum to the umbilical region. The prolapsed intestine was put back in half an hour, the duodenum sheathed in the stomach, the liver often injured, etc., etc.; in the last case, the puppy, he fitted the end of a certain intestine (not named) into the other (intestine) with the thickness of his thumb, so that the gall bladder and the pancreas would necessarily have been broken, or at least obstructed. None of these animals so badly treated lived longer than twenty-four hours afterward. Not deterred by the fatal outcome, I have tried extirpation of the pylorus on several dogs, one of which recovered."

Pean, in 1879, and Rydygier, in 1880, had unsuccessfully attempted the operation on human subjects. Billroth, in 1881, successfully removed a pyloric carcinoma, and his procedure of suturing the remaining portion of the stomach to the duodenum,

* Certain surgical observations of experiments on animals illustrated by facts. Daniel C. T. Merrem. Giessen, 1810.

end to end, became known as the "Billroth I" method. In 1885, he used gastro-jejunostomy to restore continuity following gastric resection. This became known as the "Billroth II" method. In von Hacker's article describing this procedure, the suggestion was made of termino-lateral gastro-jejunostomy, which was subsequently first performed by Kronlein. To this operation and the subsequent slight modifications of its principle have been attached, in turn, the names of von Hacker, Kronlein, von Mikulicz, von Eiselsberg, Hofmeister, Reichel and Polya.

A plastic operation on the pylorus was first performed by Heineke in 1886, followed independently by Mikulicz in 1887. Kocher's end-to-side gastro-duodenostomy following pylorectomy was reported in 1891. Lateral gastro-duodenostomy was suggested by Jaboulay in 1892, and the first report of its clinical application was made by Henle in 1898, who states that Mikulicz had suggested the method. This operation was the precursor of the method of gastro-pyloro-duodenostomy, which was reported by the speaker in 1902, and now known as "pyloroplasty." Dissatisfied with the disturbed physiology presented by the Billroth II group of anastomoses, and by their tendency to cause secondary ulceration, von Haberer, in 1922, and the speaker, in 1924, working independently, reported their experiences with the Billroth I method modified into an end-to-side gastro-duodenostomy.

In Dr. Welch's article of 1885 there are nine pages devoted to the medical treatment of gastric ulcer, with only a short paragraph on surgery devoted largely to the relief of pyloric stenosis. At that time, it was thought that the treatment was entirely medical, but that cicatrization of the ulcer by no means always cured it in the clinical sense. As a result of adhesions and scar tissue contraction, serious disturbances of the function of the stomach might follow the repair, the most important of which was stenosis of the pylorus. Dr. Welch found three successful cases in four recorded attempts at extirpation of a stenosing ulcer of the pylorus. He ventured the opinion that the resection of gastric ulcers which resist all other methods of treatment, and especially those which cause progressive stricture of the pylorus, might be considered as a justifiable operation. He noted, however, as extravagant and unwarrantable the bold suggestion of Rydygier, who advocated exploration and resection of an ulcer from which hemorrhage threatened to be fatal.

It is interesting to compare this with our views to-day, forty years after the beginning of gastric surgery. It would seem as though the greatest influence had been exerted by the tendency to regard every ulcer as a potential carcinoma, and a source of grave danger from hemorrhage, perforation or obstruction. This, combined with the advances made in diagnosis by means of the X-ray, and the establishment of a characteristic clinical syndrome, has led to the use of surgery in ulcers before the stage of cicatrization has been reached, and in ulcers elsewhere than at the pyloric orifice. The idea that the degree of gastric acidity exerts a marked influence on the healing of ulcers has distinguished a group of surgeons who advocate extensive resection of the stomach beyond the ulcer area from those surgeons who are content with more conservative measures. Dr. Welch's ultra-conservative view on the exploration and resection of bleeding ulcers, finds many followers to-day who look upon such a procedure as inferior to the benefit conferred by absolute rest, diet and appropriate medication.

But here, as elsewhere, it will be found that the large majority of surgeons of experience and mature judgment prefer to follow the middle course. Avoiding the two extremes, the one of consistent opposition to any form of operation, as advocated by some internists, and the other, the indiscriminate resection of large portions of stomach wall; suiting the operative procedure to the indications in the individual case, they as a rule make use of the more conservative types of operation, reserving the more mutilating methods for exceptional cases.

The diagnosis of gastric and duodenal ulcer lies largely within the province of the internist, as he is the one who first sees the case, but it is a sine quo non of good surgery that no operation should be performed for this affection, or any other, for that matter, without the surgeon, who has the responsibility of the operation, seeing to it that a careful history has been taken and an exhaustive physical examination made before undertaking any operative procedure. This will eliminate most of the conditions which may present the clinical picture of ulcer and with which it may be confused. Laboratory examinations will prove of great assistance in further eliminating other conditions which may obscure the diagnosis. Roentgen ray examination contributes

much in the diagnosis of gastric disease. When carefully made, the positive or negative evidence thus obtained by the experienced observer is of great value. However, it is not infallible, in fact it may at times be distinctly misleading, and should be considered only as an important link in the chain of clinical evidence. Thus the diagnosis of gastric and duodenal ulcer is based on the careful accumulation and interpretation of information derived from many sources. It is only by this thorough examination in which the heartiest cooperation between the internist and the surgeon is absolutely essential, that the best results, so far as diagnosis and treatment are concerned, are to be obtained.

The four principal complications of gastric ulcer, the first three of which are common to duodenal ulcer, namely, cicatricial contraction in healing, perforation, hemorrhage and malignant changes, do not concern us here, except in so far as the possibility of their occurrence may influence the surgeon in his choice as to the time and type of operation to be performed. When they do occur, the surgeon is faced with some of the gravest abdominal emergencies that he is called upon to meet. Then, the problem is no longer one of dealing with ulcer, but of the best method of controlling hemorrhage or closing a perforation. We will, therefore, dismiss the first three, with the simple statement that a knowledge of their possible development in the course of the life history of an ulcer would naturally influence the surgeon in favor of early operation, since preventive measures against catastrophes such as these are always far more effective than the remedies applied after they have occurred. The fact, too, that one or more of these grave emergencies may develop, in a considerable percentage of cases of both gastric and duodenal ulcer, weighs all the more heavily in favor of early operation, and in the case of the former, of a more radical one.

Perhaps a brief discussion of malignant transformation in general may help to clarify our minds with regard to the relative importance that should be attached to this possibility in deciding for or against operation. But before doing so, however, and in order to discuss this phase of the subject more intelligently, let us for a moment consider some of the more generally accepted views as to the pathogenesis of ulcer, as influencing to a greater or less extent the surgical treatment of this affection.

The origin and persistence of gastric ulcer has been the source of much speculation and experiment. Most observers agree that the action of gastric juice plays an important part in the development and chronicity of ulcer, but there have been many theories advanced as to the initial and predisposing cause. It is apparent that there is an underlying cause for the origin and persistence of gastric ulcer, aside from the contributing effect of the digestive action of gastric juice. This has been shown experimentally by the fact that when sections of mucosa have been excised, the defects heal rapidly, in the absence of this underlying factor (Mac-Callum). The action of gastric juice alone is insufficient to inaugurate ulceration in normal gastric mucosa, and is equally ineffective in preventing the rapid healing of artificially produced defects, provided the blood supply is kept intact. It is apparent from abundant experiment, that if one single factor is to be found as the basis for ulcer of the stomach, it must be closely identified with a disturbed blood supply. By analogy with chronic ulcers elsewhere in the body, this contention is borne out. Chronic ulcers elsewhere are the result of some cause acting in a fruitful soil. Even the so-called "trophic" ulcers are usually seen in regions of the body where the blood supply is relatively poor, such as the lower leg, which is a common site for chronic ulcer. Ninety-eight per cent. of ulcers of the stomach and duodenum are located in the region of the pylorus, the posterior part of the lesser curvature, the pyloric antrum and the first portion of the duodenum.* With reference to the blood supply, they are found in that part of the stomach and duodenum supplied by the right gastric artery and the gastro-duodenal artery with its supra-

* "In the year ending June 30, 1921, there were 622 cases of peptic ulcer of the stomach and duodenum, verified by operation at the Mayo Clinic. Of this number, 500, or 80.3 per cent., were duodenal, and 122, or 19.7 per cent., gastric." (W. J. Mayo, Progress in the Handling of Chronic Peptic Ulcer, —Journal A. M. A., Chicago, 1922, LXXIX, 19.)

"Ulcers of the lesser curvature, including those closely associated with the lesser curvature on the anterior or posterior wall comprise almost 90 per cent. of all gastric ulcers." (D. C. Balfour,—Surgical Management of Gastric Ulcer,—Annals of Surgery, 1921, LXXIV, 449.)

Of their 122 gastric ulcers, 110, or 90 per cent., were located in a fairly limited portion of the stomach, a portion roughly defined by the area supplied by the right gastric artery. These, combined with 500 duodenal ulcers, make a total of 610, or 98 per cent., of 622 cases of peptic ulcer.

duodenal branch (Wilkie). There would seem to be some relationship between these two facts. Pursuing the analogy further, one finds a marked relative absence of chronic ulcers of both the stomach and the legs of animals.*

Two marked differences are evident in this comparison of man and the four-footed animals. One is the upright position of man, which may be largely responsible for at least one distinctly human abnormality,—inguinal hernia.†

Another difference is the fact that in man the duodenum is retroperitoneal and largely immobile.

It is quite possible that a vascular arrangement which is sufficient to withstand the effects of various predisposing factors in animals is insufficient to provide a constantly wide margin of safety against similar factors in man.

Dr. W. J. Mayo attributes the preponderance of duodenal ulcers in males over females, partly to an anatomic reason, namely, the fact that the alkaline bile and pancreatic secretion, by reason of the more nearly transverse position in the female, bathe the upper duodenum more constantly.

If we assume that man, because of faulty adaptation of his circulatory apparatus to the upright position, is peculiarly liable to chronic ulcerations in certain parts of the body (the legs and the vicinity of the pylorus) we may possibly be less interested in

* Turck found no gastric ulcers in 189 healthy and 82 diseased dogs. (Journal A. M. A., 1906, XLVI, 1753.)

Mann found none in 200 normal dogs and cats. (Journal Experimental Medicine, 1916, XXIII, 203.)

Ivy found only one acute gastric ulcer in 900 dogs after etherization for laboratory experiment. He noted the great rarity of ulcer in dogs and cats and adds that if gastric juice digestion was a basic factor, we would expect to find more ulcers in dogs than in man, since the dog's acidity is of greater average acidity than man's. He suggests that there may be some factor present in man and absent in the dog which determines the chronicity of the ulcer. (Arch. Int. Med., 1920, XXV, 6.)

† While it is true that inguinal hernia is not unknown in the dog, it has been observed rarely in the boar, the stallion and other male domestic animals. It is remarkable that it does not occur more often, since both the tunica vaginalis and the canal of nuck in this animal remain patent. Hernia in dogs is more common in the female, a fact which Beall attributes to the occurrence of pregnancy. (Beall,—Maryland Medical Journal, 1905, XLVIII, 327, J. H. H. Medical Society.)

the many theories advanced for the initial cause of gastric and duodenal ulcer. There are doubtless many causes of the initial lesion which ultimately develops into a chronic ulcer. If the narrow margin of safety in the human be once encroached upon by some injury to the mucosa, the digestion and erosion by the gastric juice are probably sufficient to develop the chronic ulcer. This conception brings post-operative gastro-jejunal ulcers more closely into relationship with peptic ulcer.

With proper technique, segments of intestine may be resected, opened and implanted into the stomach wall. Provided the blood supply remains intact, the intestinal mucosa survives without ulceration. This indicates that intact living mucosa, other than gastric, resists perfectly the action of digestive juice, and suggests that gastro-jejunal ulcerations are the result of improper technique which endangers the blood supply. By "improper technique" is meant, among other things, the rough handling of tissues, the abuse of clamps in lateral anastomosis, the faulty control of bleeding producing hematomata of the suture line and the development of kinks and adhesions sufficient to impair the circulation of a localized area of intestinal wall.

The theories which have been advanced regarding the initial cause of peptic ulcer may be classified according to whether or not the initial lesion is regarded as inflammatory, neurogenic, circulatory, bacterial or digestive. The principles embodied in these theories have been claimed to act either independently or in combination in producing the acute ulcer and determining its chronicity.

Inflammatory Theory.—This was one of the earliest theories advanced and was advocated by Abercrombie and also by Cruveilhier, who was influenced by the evidence of inflammation elsewhere in the stomach. Various degrees of gastritis are frequently found in conjunction with chronic ulcer, but there is no basis for assuming that it may be a cause rather than a secondary result of the presence of the ulcer.

Neurogenic Theory.—This theory has had several interpretations based upon the effect produced on the different structures and functions of the stomach. A disturbance of the nerve supply of the stomach has been claimed to account for hypersecretion of gastric juice, hypermotility (spasm) of the musculature,

blood-vessel spasm and "trophic states," all of which have been associated by different authors with the condition of chronic ulceration.

The stomach is innervated both by the vagus nerve and by sympathetic fibers from the coeliac plexus. These nerves approach the stomach through the gastro-hepatic omentum, and after penetrating the muscular coats form the myenteric ganglia. Nicolaysen found these ganglia more profuse in the region of the cardia and near the pylorus. In extensive studies of the nerves adjacent to ulcer of the lesser curvature, both Permans and Nicolaysen found a definite and sometimes marked neuritis and perineuritis, and although they believed this condition to be secondary to the ulcer, they agreed in its probable effect on healing and on gastric motility.

As early as 1828, Cammerer had attempted to produce destruction of the stomach wall by resection of the vagus and the administration of acetic acid. There have been countless reports of experiments involving either the vagus or splanchnic nerves, many of which are contradictory. Ijzeren, in 1901, showed that after section of the vagus, ulcer was not obtained as usual, if a gastro-enterostomy was performed at the same time. Other authors, however, have not consistently observed ulcers following section of the vagus, so these results were not definite, and until Payr's work (he succeeded in producing chronic ulcers) were inseparable from normal healing. Dalla Vedova found ulcers in 41 per cent. of attempts after experimental destruction of the coeliac ganglion, and in 60 per cent. after destruction of the splanchnic nerve. Kobayashi and Kanamura observed multiple erosions of the gastric mucosa not only after pricking or extirpating the coeliac ganglion, but also after section of the spinal cord or ligation of the vagus nerve.

Rost states that if it can be shown that there is not only a definite constitutional weakness in individuals with ulcers, but an actual predisposition of the vessels in the neighborhood of the stomach to cramp, a factor of importance will have been discovered. Unfortunately, the information derived from many conflicting results of work along these lines has been of little value in its application to the treatment of the condition.

Circulatory Theory.—As a cause of simple ulcer, local circulatory disturbances with arrest or impairment of the circulation in a circumscribed part of the stomach wall have been supported by the work of many experimenters. The scope of most experiments has extended from attempts to interfere with a localized area of the mucosa, to efforts directed toward the disturbance of the circulation of the entire stomach, both directly and indirectly. Rokitansky was the first to note hemorrhagic necrosis of gastric mucosa, and his observation was followed by Virchow's description of digestion following hemorrhagic infiltration induced by local impairment of circulation. Conditions which may effect the circulation of any part of the stomach wall include embolism and thrombosis, diseases of the vessel wall, such as atheroma, endarteritis obliterans, fatty degeneration, amyloid degeneration, miliary aneurysms and varicose dilatations, compression and obstruction by spasm of the muscular coats of the stomach wall and vaso-constriction of neurogenic origin.

In favor of the circulatory origin of chronic ulcer is the fact that parts of the stomach wall from which the circulation has been shut off are subject to digestion. This is confirmed by the production of ulcers experimentally, after injecting into the gastric arteries substances acting as emboli. Also, hemorrhagic infractions, the hemorrhagic infiltration of acute ulcers, and their frequent funnel-like shape suggests their circulatory origin.

On the other hand, the infrequency of demonstrable changes in the blood vessels about an ulcer, the fact that ulcer occurs earlier than the age when arterial disease is usually present and the absence of ulcer in most cases of heart and arterial disease may be considered evidence against the circulatory theory.

These objections have been met by the contention that the disturbance of the circulation is an intermittent affair, the anatomic demonstration of which is impossible. The circulatory theory is here closely associated with the neurogenic theory in its explanation of the local anemia. As stated above, Klebs supports the idea of local spasmodic contraction of gastric arteries, with temporary interruption of circulation. Orth suggested that compression of the gastric vessels by spasm of the muscular coats of the stomach, occurring in vomiting and gastralgic attacks, results in hemorrhagic infiltrations which may develop into ulcers.

Attempts made to interfere directly with the circulation in parts of the stomach wall include procedures on the larger vessels and on the capillary distribution. Littauer's observations have been confirmed by Ivy, who ligated six to eight branches of the gastro-epiploic vessels supplying the pyloric portion of the stomach, with negative results. Braun demonstrated that four-fifths of the blood supply of the stomach may be cut off without necrosis. Fibich was able to produce chronic ulcers by ligating arteries, excising a portion of mucosa and cauterization of the base. This procedure, however, in the hands of Clairmont did not produce ulcers. An indirect result of these experiments has been the proof that as far as surgical procedures are concerned, the stomach is a very viable organ.

Cohnheim produced ulcers by injecting lead chromate into the gastric artery, and Payr obtained chronic ulcers by injections of formalin, dermatol and India ink. This method of injecting aseptic emboli had been used by Klebs and Welti, and recently by Ivy. Ivy obtained negative results with a bland substance, such as charcoal, and it would seem that Cohnheim's and Payr's work was not illustrative of the effects of purely aseptic emboli, but brought into consideration the actual destruction of tissue. Ulcers may be produced in this manner, which is properly a variety of trauma analogous to Roth's method of injecting silver nitrate solution into the mucosa, or even related to Daettwyler's ulcers produced by mechanical, chemical or thermal irritants applied through a gastric fistula.

The idea that the origin of gastric ulcer depends on diseased conditions of blood vessels is supported by the findings of a comparatively small group of cases. Changes in the blood vessels of the stomach have been seen in a considerable number of cases of gastric ulcer (according to Nicolaysen, 75 per cent.) and gastric ulcer has been recorded in association with most of the diseases to which blood vessels are subject. Examples of embolism of the artery supplying the ulcerated area of the stomach have been reported, but many are open to criticism.

Thrombosis of the vessels about an ulcer has been observed, and in some cases the thrombosis has been prolonged considerable distances beyond the ulcer. Atheromatous changes are not infrequently seen. Obliterating endarteritis, already mentioned,

is probably secondary, similar to that found near tuberculous cavities in the lung. Miliary aneurysms occurring independently or associated with ulcer have been described. In the majority of cases, however, no changes are found in the blood vessels of the stomach except those apparently secondary to the ulcer.

Ever since Virchow attached particular importance to disturbances in the circulation of the stomach in the pathogenesis of ulcer, especial interest has attached to the relationship between gastric ulcer and diseases of the heart and blood vessels. As might be expected, ulcers are found in a small percentage of cases in which blood-vessel changes regularly occur, including atheroma, syphilis, and nephritis. But there are many not so associated, and it will be recalled that the age of onset of gastric ulcer in nearly 70 per cent. of cases is under forty years.

Wilkie demonstrated that the blood vessels of the first part of the duodenum differ greatly from those of the remainder. The superior portion is dependent on a variable branch of the gastroduodenal artery, which he designated the supraduodenal artery. He also called attention to the scant anastomoses of the terminal portion of the vessels in this region. Berlet recently published his results with injections somewhat similar to Wilkie's. He found the profuse anastomoses of the greater portion of the stomach greatly diminished at the pylorus, and that the actual size of these vessels was small. He concluded that this condition pre disposed to circulatory disturbances and was less able to establish compensatory anastomoses in the event of disturbances. This anatomical demonstration of a relatively poor blood supply of this important region of the stomach and duodenum is quite in accord with the idea that the upright position of man always plays considerable part in the pathogenesis of ulcer. Krempelhuber states that anaemia of the mucosa can be brought about purely mechanically by the gastroptosis, which according to him is present in 88 per cent. of cases of ulcer.

Bacterial Theory.—Böttcher early advocated the theory that stomach ulcers were of infectious origin. The rôle of bacteria has been considered twofold, embolic and toxic. The embolic theory leads again to the idea of local circulatory disturbance, while the toxic assumes a specificity against gastric mucosa comparable to the gastro-toxin of Bolton. Many bacteria have been

described as the causal agents of ulcer, but for the most part they have been considered secondary. Intravenous injections of different bacteria have yielded no constant results. Bolton was convinced that the commonest cause of necrosis of the mucous membrane, resulting in acute ulcer, is bacterial infection through the blood stream and that the necrosis was due to direct effect on the tissues of bacterial poison alone or combined with the action of gastric juice.

A most significant and interesting work has been that of Rosenow, of the Mayo Clinic, who has shown the selective affinity of streptococci, which are capable of reproducing lesions peculiar to the particular strain. Rosenow's summary of his work in 1916 was as follows: ''The ulcers produced by the injection of streptococci resemble those of man in location, gross and microscopic appearance, and in that they tend to become chronic, perforate or cause a severe or fatal hemorrhage. Streptococci having a characteristic affinity for the stomach and duodenum have been repeatedly isolated from various foci of infection in patients with ulcer and from ulcers themselves. They tend to disappear from the circulation and do not commonly produce marked lesions otherwise. They have been isolated from ulcers in animals, and ulcer has again been produced on their re-injection. Filtrates of these cultures have no special tendency to produce ulcer.'' He states in conclusion: ''The small ulcer of the stomach and of the duodenum in man is primarily due to a localized haematogenous infection of the mucous membranes by streptococci.'' Rosenow's conclusions have not been unreservedly accepted by bacteriologists. Although streptococci are present in practically all gastric ulcers, doubt has been expressed that these organisms have been proven to be the factor which either initiates the ulcer or prevents healing. In spite of this, most surgeons have made practical application of the principle that the treatment of gastric ulcer should be reinforced by a thorough search for and elimination of all possible foci of infection elsewhere in the body, appendix, gall bladder, teeth, tonsils, etc.

Digestive or Corrosive Theory.—The importance of the gastric juice in the production and development of ulcers has long held the attention of surgeons. It is now generally thought that gastric juice has little or no part in the initiation of ulceration, but

that its digestive action, after injury to the mucosa, is an important contribution toward the chronicity of the ulcer. It is even probable that these two factors—initial injury and subsequent digestion—if unaccompanied by a continuance of the underlying cause, are insufficient to prevent healing. Without previous injury, the gastric mucosa resists digestion. With ordinary injuries, gastric digestion alone is insufficient to prevent healing. Many attempts have been made to explain this resistance of gastric epithelium. Hunter believed that resistance to digestion is a general property of all living uninjured cells. This would seem to be disproved by the common occurrence of digestion of the skin about a gastrostomy opening. Also, Claude Bernard noted digestion of the thigh of a living frog which was placed in a gastric fistula; and Pavy observed the same effect on a rabbit's ear. Matthes' explanation that the living tissue was killed by hydrochloric acid before digestion took place does not solve the difficulty. Epithelium other than gastric is able to resist this action of hydrochloric acid, which may be properly included in the digestive process. Hanrahan has recently implanted into the stomachs of dogs, resected and opened loops of small intestine, preserving carefully their viability, and has noted superficial erosions in only a small number. The problem apparently deals not with living uninjured tissue as such, but with the explanation of the protective power of alimentary mucosa against gastric digestion. This resistance has been attributed to the presence of mucin in the mucous secretion of the pyloric antrum and to the presence of a so-called antipepsin. The theory, therefore, that the resistance of gastric mucosa against autodigestion is due to the presence of antipepsin and that a diminution of this substance in the stomach wall is followed by ulcer, has not as yet been proven.

The multiplicity of methods by which acute ulcers may be experimentally produced has probably cleared rather than obscured the problem of pathogenesis. Ivy, whose important work has touched on most aspects of the physiology of the stomach, concluded that acute ulcers may be produced by anything that causes a local necrosis by direct, toxic, or chemical action on mucosal cells, or by interfering with or disturbing the normal condition of the capillaries of the mucosa. He classified the chief theories as regards the pathogenesis of ulcers as follows:

1. Infection of the mucous membrane through the blood by specific or non-specific bacteria from a focal infection, is the primary factor and source of re-infection;

2. The corrosive action of gastric juice on mucosal cells that in some way have had their normal resistance against acid-pepsin digestion diminished, prevents healing;

3. Localized trophic disturbance is responsible for chronicity of the ulcer;

4. A general condition of autolysis plays the important rôle.

The peculiarity of stomach ulcers is probably due not to any specific cause, but to the digestive action of the gastric juice, which keeps clean the base and sides of the ulcer. The clean edges and base incident to all ulcers of the stomach justify no conclusion as to the cause of the ulcer. Peptic ulcers probably originate from various causes acting upon favorable tissue—that part of the stomach and duodenum supplied by the right gastric artery and the gastro-duodenal artery, with its supra-duodenal branch. The initial injury is rendered chronic by the continuous erosive action of the gastric juice, which is aided in its effect by adjacent (secondary) neuritis, perineuritis, and obliterating endarteritis. In other words chronic ulcer of the stomach and duodenum is due in all probability not to a single cause acting alone, but to a combination of causes acting more or less together.

Malignant Transformation.—First suggested by Cruveilhier in 1829, the tendency of gastric ulcers to become cancerous has been commented on repeatedly by pathologists and surgeons since that time. That ulcer of the stomach may be the origin of carcinoma seems definitely established. It is of considerable importance to the surgeon, inasmuch as his treatment of gastric ulcer must be profoundly influenced by his opinion of the proportion of simple ulcers in which this carcinomatous change may be expected to develop. The surgeon who believes that this proportion is over 50 per cent. will obviously advocate more radical procedures than the surgeon who believes it to be less than 5 per cent.

Cabot and Adie have recently reviewed the trend of opinion on this subject and have shown the fluctuations of surgical opinion on the estimated percentage. From their article it is found that of 82 reports, 74 authors believed that less than 10 per cent. of gastric ulcers develop carcinoma; while 15 authors believe the

frequency to be over 50 per cent. This wide variation indicates that while the tendency is recognized, the criteria on which opinions are based differ greatly. It is of vital importance that these criteria be so established that published reports will have some common basis for comparison. The solution of the problem has been approached by three methods of study:

1. The comparison of the occurrence of ulcers and carcinoma by the statistical method;

2. The study of the history of cases of ulcer and carcinoma with the attempt to differentiate one from the other at some stage. Likewise the study of the life history of ulcer, treated conservatively;

3. The study of the gross and microscopic pathology.

Little of the information gained from any one of these methods may be considered as of positive value. The material may unconsciously be used to support a preconceived idea, which would detract immeasurably from a conclusion which is at best inferential. However, if it is found that the frequency of occurrence as estimated from all of these methods regularly falls near a common figure, we have valuable evidence which would enable us to discount any unusual figures which would be arrived at by the use of only one method of study.

Williams has made extensive use of statistical evidence and regarded it as incompatible with the frequent origin of cancer from ulcer. His conclusions were based on the sex and age incidence and the comparison of the location of ulcer and carcinoma.

Clinical evidence has been furnished by many observers, and there are definite examples reported in which carcinoma has been preceded by a long history of ulcer. A very sound objection to inferences drawn from this is the difficulty not uncommonly encountered of differentiating clinically, gastric from duodenal ulcer. Several authors claim that the transition from simple ulcer to carcinoma is marked by the change from hyperacidity to anacidity, the appearance of a tumor, and cachexia in the course of long observed cases. Lockwood, in 174 cases of gastric carcinoma, found a suggestive history of ulcer in 7 per cent., and definite in 3 per cent. Less than 5 per cent. of carcinomas developed in 346 ulcers of the stomach treated by medical measures and observed by Greenough and Joslin, and by Hemmeter. Jos-

lin later published figures showing that 24 per cent. of the late deaths following operation for gastric and duodenal ulcers were from cancer of the stomach. From studies of the literature Galpern found a small percentage of recurrences in the form of carcinoma, and Gressot places the frequency at 23 per cent. Balfour reports that in 799 cases operated on for gastric ulcer at the Mayo Clinic, 33 or 4.1 per cent. died of cancer during a seven-year period. In 1,610 cases cited by Ewing, the frequency was 2.2 per cent., and this author believes it quite possible that some of these were originally cancer. Ewing states that from clinical evidence it may be concluded that a great number of ulcers have been treated medically for some years without developing cancer; that the number developing cancer after gastro-enterostomy is not appreciably larger than after resection of the ulcer; that a diagnosis of cancer following ulcer, to be acceptable, should carry with it a previous history of ulcer; that this history covers a period of ten to thirty years in certain well attested cases, while in less satisfactory but possibly genuine cases the history of ulcer covers only two years.

The microscopic examination probably accounts for the greatest variation of opinion as to frequency. When the ulcerated primary carcinomas are eliminated, there is left a group of chronic ulcers in whose edges are changes that have been interpreted by some as inflammatory hyperplasia, by others as carcinoma. Wilson and MacCarty are perhaps the chief modern exponents of the latter contention. On the basis of their studies and their interpretation of cellular pathology they have estimated the proportion of ulcers which develop secondary carcinoma as 68 per cent.; and also, the proportion of carcinomata which develop from pre-existing ulcer as 71 per cent. Ewing feels that these inflammatory hyperplasias and misplacements may well be considered as precancerous lesions, but that on the other hand, there is no direct evidence to show that any given precancerous lesion would if undisturbed go on to develop cancer. Indeed, Galpern and Bamberger's observations on the fate of gastric ulcer after gastro-enterostomy seem to prove that these lesions seldom do go on to produce cancer.

While we believe that carcinomatous transformation does not occur in more than 10 or at the most 15 per cent. of gastric ulcers,

there is another more practical phase of the question that is not answered by the academic discussion. The operating surgeon should be able to classify the lesions which Ewing says readily fall into two groups, simple ulcers and primary ulcerated carcinoma. If he is unable to differentiate these, and in addition believes that over 50 per cent. of the former develop secondary carcinoma, he will be consistently radical in his procedures. On the other hand, the surgeon who recognizes and differentiates between simple ulcer and ulcerated carcinoma either from the gross appearance described above, or with the aid of a microscopic pathologist with whose criteria he is in accord, and who does not consider local migratory hyperplasia indicative of cancer, will have little hesitancy in treating simple ulcers conservatively.

The problem may present itself according to what proportion of ulcerated lesions the surgeon is able to identify at the operating table. It is our impression that about 85 per cent. of such cases may be recognized without microscopic aid; that about 10 per cent. more will be identified by means of frozen sections, and that in about 5 per cent. both the surgeon and the pathologist will be uncertain as to their true nature. We do not feel that 70 per cent. of chronic ulcerated lesions unaccompanied by tumor or metastases, are carcinomatous. We feel that about 85 per cent. of simple ulcers are recognizable as such on the basis of chronicity, the character of the edges and base, and the absence of tumor or metastases. Of the remaining 15 per cent., on microscopic examination about 5 per cent. will be found entirely benign; another 5 per cent. will present recognizable carcinoma; while the remainder will require microscopic study of serial sections to ascertain their true character.

Surgical Treatment.—The operations usually performed for ulcer of the stomach may be considered as being either conservative or radical. The conservative group may be subdivided into the following procedures: (1) procedures directed toward local excision, cauterization or suture of the ulcer; (2) local excision, etc., plus gastro-enterostomy or pyloroplasty; and (3) gastro-enterostomy or pyloroplasty alone. An operation may be considered radical when the effort is made to remove not only the ulcer, but also that part of the stomach which develops 90 per cent. of ulcers (the so-called ulcer-bearing area of Rodman).

Following this partial gastrectomy, continuity is restored by means of some modification of the principle involved in either the Billroth I or Billroth II anastomoses.

In his choice of operation the surgeon should be wholly influenced by the condition of his patient. The general condition may be greatly affected by such complications as hemorrhage or perforation, with resultant shock, which would restrict the extent of surgical intervention. Such local conditions as dense adhesions or peritonitis might limit the extent of operative procedures. The surgeon, therefore, should be guided directly by the conditions found in the individual case. If a chronic ulcer is operated upon in a quiescent stage, the limitation imposed by the patient's general condition may not be in force. The operative procedure selected will then be determined by the surgeon's opinion regarding the following important considerations: (1) the importance of removal of the ulcer-bearing area of the stomach; (2) the efficacy of the reduction of gastric acidity by a large resection; and (3) the possibility of subsequent carcinomatous transformation.

Pre-Operative Preparation.—Previous to all surgical operations upon the stomach, there should always be a period of preliminary preparation, unless, of course, the operation is in the nature of an emergency. It has been our invariable practice for many years to prepare our patients according to a regular routine. In patients so prepared infection has been reduced to a negligible quantity. We prepare our patients as follows:

For several days previous to the operation the patient is instructed to brush his teeth thoroughly with an antiseptic toothpaste and rinse the mouth with a one per cent. carbolic acid solution several times a day. For the same length of time he is kept on a sterile diet, *i.e.*, cooked foods, pasteurized or boiled milk, eggs, orange juice, boiled water, etc. If there is gastric stasis present, lavage once or twice a day, depending upon conditions present, should be employed. Repeated observations by various authors, notably Cushing and Livingood, observations which have been abundantly confirmed by us in cultures taken from both stomach and duodenum upon the operating table, have convinced us that the acid stomach will sterilize itself in approximately forty-eight hours, if no infectious material is meanwhile ingested.

However, this rule does not apply in case of ulcerating carcinoma of the stomach walls. In the latter condition we have recovered various forms of bacteria, especially the streptococcus pyogenes.

The routine comprehensive physical examination of the patient demanded by good surgery should never be omitted, except in case of dire emergency. Starved, dehydrated and exsanguinated patients should be given benefit of the therapeutic measures indicated in the individual case. Fluids should be forced on the patient, and if the gastric condition limits the amount which can be given by mouth, we rely on hypodermoclysis and proctoclysis. Transfusions are given when the percentage of haemoglobin is under sixty.

In the choice of anaesthetic, due consideration should be given to the claims of local as against general methods. More and more is it becoming evident that when properly used, regional nerve block combined with either anterior or posterior splanchnic block yields excellent results. The administration of a general anaesthetic should always be in the hands of the most competent anaesthetist available. The fundamental rules of good surgery, meticulous attention to details, complete asepsis, gentle handling of tissues, absolute haemostasis, and the avoidance of undue haste, should invariably govern the surgeon's every action. When scrupulously observed, they to a marked degree, favorably influence the ultimate result.

Perforation.—This complication occurs in about 28.1 per cent. of gastric ulcers, and is responsible for about 7 per cent. of the deaths from this condition as found at autopsy. Of all the catastrophes that require the help of the surgeon few are more urgently insistent in their demands upon his resources than is a perforated gastric ulcer. Not only is the life of the patient seriously jeopardized by the rapidly ensuing peritonitis, but the frequently accompanying shock and agonizing pain demand the earliest possible relief. It is of the utmost importance then, that an early provisional diagnosis be made in order that valuable time may not be lost. The most characteristic feature of acute perforation of a gastric ulcer is a sudden unheralded pain in the epigastrium. This pain is described in various terms by different patients, but all agree upon one point, namely, its extreme severity. The patient lies in one position not daring to move; his body is

tense and rigid; he will not tolerate any manipulation by the examining surgeon, so sensitive is the abdomen, especially over the region of the perforation. The patient usually presents the classical appearance of profound shock, with the single and marked exception that there is little corresponding change in the pulse. Its character and rate are, at first, surprisingly little affected by the perforation, but rapidly change as soon as the resulting peritoneal inflammation becomes well established. But this should never be allowed to occur, unless the patient is out of reach of competent medical help at the time of perforation. Quickness of action is the essence of good management in an emergency of this character. In the presence of the clinical picture just described, neither the doctor nor the surgeon can be held blameless who will allow a moment's unnecessary delay, even to make a positive diagnosis, before opening the abdomen. The real question to be decided is not so much "What has happened?" but rather "Has something sufficiently grave transpired within the abdomen as to seriously threaten, in its consequences, the life of the patient?" If so, it is far safer to open the abdomen immediately, while the patient is still in good condition, rather than run the risk of peritonitis, or hemorrhage, or strangulation, or what not, and so lose the golden opportunity, while waiting to make a finished diagnosis. If err we must, as sometimes we may, let us be sure to err on the safe side. In other words, when in doubt, operate. This is often the more conservative course.

Moynihan's classification of perforation of the stomach into acute, subacute, and chronic types is excellent. All of them are essentially surgical and should be so dealt with, appropriate measures being applied to the individual case. If the ulcer happens to be situated on the anterior wall near the pylorus, as occasionally happens, the operation of choice is a pyloroplasty so modified as to include the ulcer together with its perforation, between the anterior and posterior suture lines, thereby excising the whole area. I have frequently done this in the case of perforating duodenal ulcer and a few times in perforating gastric ulcer situated close to the pylorus, without materially disturbing the regular technique of the pyloroplasty. However, when the perforation occurs along the lesser curvature, as is more often the case, the choice of operation lies between:

1. Suture of the perforation;

2. Suture of the perforation together with posterior gastro-enterostomy;

3. Partial gastrectomy followed by one of the usual methods of gastro-intestinal anastomosis.

Some authorities, Deaver for instance, insist upon closure of the perforation followed by gastro-enterostomy as a routine procedure; while others, headed by Moynihan, practice it only when the exigencies of the case, such as pyloric obstruction or multiple ulcers demand it. The latter course has been our own custom, as it has always seemed advisable to limit the length of time of operation to the minimum, owing to the condition of the patient; and furthermore, the cases in which gastro-enterostomy was not done have seemed to do as well as, or even better than, those in which it was practised.

Certain difficulties will be encountered in the course of the operation. In the first place, the patient will be suffering from more or less shock and collapse as a result of the perforation. Every precaution should be taken to combat this condition with the recognized means at the surgeon's disposal. After the abdomen has been opened, it may not always be easy to find the perforation, even through an incision of ample length which should always be made. The high right rectus incision is the incision of choice. Aids to the location of the ulcer will be the presence of thick masses of fibrinous exudate, or escaping fluids through the perforation in the stomach or duodenal wall. If the perforation does not readily present itself, search should be made in the region where it usually occurs, namely, in the neighborhood of the pylorus along the lesser curvature. As soon as it has been found, that part of the stomach should be gently drawn up into the wound, and isolated from the rest of the abdominal cavity by gauze pads wet with warm salt solution. The perforation and surrounding area are then carefully inspected while the surgeon is determining his subsequent course of action. It should be emphasized that here as elsewhere, every case is a law unto itself. The surgeon's problem is to apply to this particular case that particular form of operative procedure which in his judgment is most suitable to the conditions present. It is bad practice and worse surgery to attempt to adapt any one course

of treatment, no matter how good it may be, to every case. One but courts disaster in pushing any operative procedure beyond its natural limitations. All that will usually be found necessary, after having found the ulcer and cleaned off the deposit of fibrin, is to infold the edges and keep them approximated as best one can by that form of suture most easily adaptable to the conditions found. Personally, where the edges of the ulcer and adjacent walls of the intestine are found to be rigid and indurated owing to oedema and round cell infiltration, the interrupted mattress suture of Halsted has been found most satisfactory, as it includes a better bite of tissue than other types and secures better inversion. The continuous suture, which is easier and quicker than any other, may be reserved for less trying conditions.

It is always well to reinforce the suture line with omentum or with other adjacent and available tissues. Before closing the abdomen, we have made a practice of turning the omentum upward under the liver and between the stomach and the anterior abdominal wall, relying on it to reinforce the suture line still further, and to limit the area of possible infection. The question of drainage is a debatable one. Some authorities advise drainage as a routine practice; others, led by Yates, oppose it. As a general rule, our own inclination is to follow the latter course. Therefore, we seldom drain. There are occasional exceptions, however, particularly in those cases operated upon late, after a peritonitis has become pretty well generalized. It is a good rule to drain thoroughly if one drains at all. This means multiple drains placed in dependent portions as indicated, and brought out through stab wounds in the flanks and above the pubes, or in the case of women, through the vagina. We prefer cigarette drains, two at each point, as two drains act better than one. Others prefer rubber drainage tubes. Early removal of drains is to be encouraged.

Differences of opinion are to be found among surgeons of experience with reference to the toilet of the peritoneum. Authority can be found for almost any method that one may employ. In general it may be said, however, that the same rules with regard to the gentle handling of tissues apply with equal force to the inflamed peritoneum as elsewhere. It is a serious question whether or not more harm than good may be done by attempting

more than the removal of gross particles of food and other material readily accessible. The thing to be feared is the subsequent development of abscess formation arising from the pocketing of pus in various localities. Especially is one to be on one's guard against subphrenic abscess, always a very serious postoperative complication, which should be recognized early, in order that it may be promptly dealt with.

If for any reason it is decided to perform a gastro-enterostomy after having closed the perforation, the same principles should govern as in uncomplicated cases. If on the other hand, owing to the suspicious appearance of the ulcer, or the inability of the surgeon satisfactorily to handle otherwise the problem presented, a partial gastrectomy appears indicated, it differs in no way from the usual method of performance.

We have thus far been dealing with the management of acute perforations. The same principles apply in the case of subacute perforation, the only difference being that, owing to the more minute character of the perforation, there is greater likelihood of finding the infected area walled off by protective adhesions, and a correspondingly decreased extravasation of stomach contents. The problem of the surgeon is therefore simplified to the extent that he is dealing with a localized rather than a generalized process. In the case of the chronic perforation the problem usually resolves itself into the treatment of a perigastric abscess. The methods employed should vary according to the location of the abscess and the other structures involved, *e.g.,* subphrenic abscess, the pancreas, liver, etc.

The post-operative care of these patients is of the utmost importance. It consists in proper posture, the maintenance of the Fowler position, forced fluids by every avenue except the mouth for the first few days; the Murphy drip, subcutaneous and intravenous infusion of normal salt solution, and in extreme cases, blood transfusion. After the first day or two water, crushed ice, and other fluids may be cautiously administered by mouth in gradually increasing quantities. Morphia in sufficient quantity to keep the patient quiet and reasonably comfortable is always indicated. Withholding it, except in case of individual idiosyncrasy is to be condemned.

Classification of Surgical Treatment.—The surgical treatment of chronic (non-perforated) peptic ulcer may properly be considered under three main heads:

1. Excision.
   a. Simple excision of the ulcer.
   b. Excision combined with pyloroplasty.
   c. Excision combined with gastro-enterostomy.

2. Gastro-enterostomy.
   a. Gastro-enterostomy alone.
   b. Combined with excision.
   c. Combined with jejunostomy.

3. Resection of a portion of the stomach.
   a. Resection of body (sleeve or wedge).
   b. Partial gastrectomy.
   c. Total gastrectomy.

This classification is obviously quite arbitrary, but it forms a good working basis and is readily understood.

The Operations for Chronic Ulcer.—About 90 per cent. of gastric ulcers occur at or near the pylorus or along the lesser curvature, and the danger of stenosis attending simple excision in this location contra-indicates this procedure. Depending on the position and size of the lesion, the operations of choice for the majority of chronic gastric ulcers include pyloroplasty or gastro-enterostomy with excision of the ulcer, and partial gastrectomy followed by gastro-duodenostomy or gastro-jejunostomy. It is obvious that simple excision of ulcers which are located on the anterior or posterior wall of the body of the stomach is probably rarely performed. In addition to the anatomical difficulties presented, the surgeon is doubtless influenced by his desire to perform a more corrective operation.

When the ulcer is located at the pylorus, or in the pyloric portion of the anterior wall, a pyloroplasty presents the advantages of excision of the ulcer, with a reconstruction of the pyloric orifice in such a way that the possibility of stenosis is entirely eliminated. For those to whom this procedure appeals, the Finney pyloroplasty, the Heineke-Mikulicz operation and its modifications, as practised by C. H. Mayo and J. S. Horsley, offer many possibilities. If a pyloroplastic operation is not used, the opera-

tor will probably perform either a gastro-enterostomy with or without excision of the ulcer, or the more radical procedure, partial gastrectomy with restoration by one of the modifications of the Billroth I or II.

If a local excision of a pyloric ulcer is performed, the ensuing closure may obliterate the pyloric orifice, and unless combined with pyloroplasty, as mentioned above, gastro-enterostomy must be performed. Gastro-enterostomy with an obstructed pylorus will, as a rule, give better clinical results than one performed in the presence of a patent pylorus. If the ulcer is not excised, good results may be obtained from gastro-enterostomy, and healing of the ulcer probably takes place in most cases. We do not agree with the high figures quoted by some for carcinomatous transformation. If possible, however, the ulcer should be excised because there is always the possibility that the lesion may be primarily a cancer, or that cancer may later develop.

The radical partial gastrectomy for pyloric ulcer has many advocates. The arguments in favor of this procedure are that it removes the ulcer-bearing area of the stomach (Rodman), and that gastric secretion is diminished by the removal of a large portion of normal gastric mucosa. Advocates of this wide resection feel that the incidence of postoperative gastro-intestinal ulcers is thereby greatly lowered, and also that in capable hands the operative mortality does not exceed the mortality after gastro-enterostomy. When the ulcer is further removed from the pylorus other operative methods are to be employed, depending upon the location of the ulcer, its size and its relation to surrounding structures.

In dealing with ulcers situated along the lesser curvature, several courses are open. Simple gastro-enterostomy or pyloroplasty may be performed or may be combined with local excision of the ulcer, which in this location may be carried out with a wedge- or V-shaped resection. Sleeve or segmental resections have occasionally been used to advantage here. Ulcers situated high on the lesser curvature are perhaps better treated by the more radical partial gastrectomies, or if resection is not done, by gastro-enterostomy followed by jejunostomy as recommended by Moynihan.

Ulcers elsewhere than at the pylorus or on the lesser curvature may more often be treated by simple excision and closure, without the pressing necessity of pyloroplasty, or gastro-enterostomy. Sleeve resections offer some possibilities, but we feel that the cases which may be suitable for this procedure are better treated by partial gastrectomy, followed when possible by the von Haberer-Finney modification of the Billroth I restoration, or by one of the modifications of the Billroth II.

If the ulcer has become adherent to the pancreas, liver, or less rarely the spleen, it may be excised and the base simply cauterized and left in place, and the stomach restored as above. Drainage to this area is usually advisable.

Discussion of Operations for Gastric Ulcer.—In considering stomach operations as a whole, we find that they may be divided into two groups based on the type of restoration as compared with normal anatomy and physiology. On the one hand we may have the pyloroplastic operations, and gastro-duodenostomy after partial gastrectomy. In this group of operations the restoration of gastro-intestinal continuity follows the normal arrangement— stomach to duodenum without blind loops. On the other hand, there are the operations depending on the principle of short-circuiting, such as gastro-enterostomy, the Billroth II and its modifications. Following this type of operation, there are two openings from the stomach, also the gastric contents enter the jejunum, which is by nature not well adapted to withstand the effects of gastric juices. Added to this, there is the ever present danger of retrograde filling of the closed loop.

For purposes of discussion we will contrast pyloroplasty with gastro-enterostomy, and gastro-duodenostomy as opposed to the Billroth II and its modifications, as the choice of operation is usually made between these.

Pyloroplasty vs. Gastro-enterostomy.—Pyloroplasty as usually carried out eliminates the possibility of pyloric stenosis by the abolition of the pyloric ring. There remains no sphincteric action and the size of the opening from the stomach is limited only by the diameter of the duodenum. After the operation there is a reduction of gastric acidity, brought about by two factors, abolition of pyloric stenosis and the effect of bile and pancreatic juice regurgitated into the stomach. In nearly every case

the total quantity of acid as well as the percentage of free hydrochloric acid, which may be high before operation, is gradually reduced to normal. This does not occur immediately after operation but requires about two months before the normal is established, after which it remains stationary. Hughson found that this gradual reduction of gastric acidity seems to parallel a gradual reduction in the emptying time as observed under the fluoroscope. There is apparently a two-months' interval before the maximum beneficial effect of pyloroplasty is seen, during which careful attention should be paid to the dietary régime.

Gastro-enterostomy is apparently not a drainage operation, but depends for its beneficial effect on the reduction of gastric acidity by regurgitation of alkaline duodenal contents into the stomach. The effect of gastro-enterostomy upon the physiology of digestion has received much attention. Haertel, Schueller, and Petrén showed that in the presence of a patent pylorus the peristaltic wave is unchanged after gastro-enterostomy and that food passes in equal parts through the pylorus and the stoma. Cannon and Blake have shown that unless the stoma is placed very near the pylorus, the gastric contents even when fluid are pushed through the pylorus rather than through the stoma. This work was supported by that of Guibe, Hartman, and Kelling, but disagreed with by Outland, Skinner, and Clendenning, who claimed that gastro-enterostomy is a drainage operation and prevents passage of food through the pylorus. Kelling's work, antedating Cannon's, offers material support to the latter in that after experimental gastro-enterostomy, of 250 cc. of methylene blue in water administered by mouth, 235 cc. were recovered from a duodenal fistula and only 15 cc. from a jejunal fistula. We are able to offer experimental work in support of Guibe, who found that as long as the pylorus remains patent, the stomach has a marked tendency to drive out its contents through that orifice without being inclined to utilize the artificial mouth. Hanrahan has sectioned the duodenum in dogs, in its first part just above the ampulla, and performed gastro-enterostomy on the greater curvature, immediately over the vertebral column. The stoma was four to five cm. in length, but on resumption of feeding was not utilized, with the result that the duodenal blind end in every case was ruptured. Cannon and Blake frequently observed circula-

tion of food but not the symptoms of vicious circle, which is brought about when there is a kink or other obstruction just distal to the anastomosis. The probability of a circulation of food whenever the pylorus is left open, the non-mixture of the food with the digestive and neutralizing fluids in the duodenum, and the ever present danger of kinks are some of the factors contributing to make gastro-enterostomy a not ideal operation.

In pyloroplasty these objections, according to Cannon and Blake, are avoided. Too rapid exit of food through the pylorus is prevented by rhythmic segmentation of food in the duodenum, an activity which in part replaces the function of the pylorus and also mixes food with pancreatic juice and bile.

In addition to its unphysiological aspects, gastro-enterostomy may be attended by the none too rare complication of gastrojejunal ulceration. We have seen duodenal ulceration follow pyloroplasty in only two instances, probably a persistence of the original ulcers. One appeared after five years, another after one and a half years. In both cases the operation had been performed for duodenal ulcer which we were unable completely to excise at operation. This rarity may of course be explained by the fact that we never use clamps in performing this operation. From experimental work and from clinical observations we have come to the following conclusions regarding the causation of postoperative gastro-jejunal ulcers: (1) while the intestinal mucosa with intact circulation has the general property of resisting gastric juice digestion, there is a slightly increasing susceptibility to this digestion, the farther the anastomosis is made from the pylorus; (2) secondary ulceration occurs most frequently when gastro-enterostomy is performed in the presence of hyperacidity or, more rarely, achylia; (3) the most direct cause of secondary ulceration is faulty technique, such as the improper use of clamps and haemostatic sutures. Montgomery, in 1924, called attention to haematomata in the suture line as a cause of ulceration, and also to the unimportance of the type of suture material.

It is on the basis of a comparison of our results following pyloroplasty with those following gastro-enterostomy that for the reconstruction following partial gastrectomy we advocate the termino-lateral Billroth I type, (the Haberer-Finney method) rather than the Billroth II or its modifications.

We object to the Billroth II group of operations for the same reasons that we object to gastro-enterostomy. To be sure, the incidence of gastro-jejunal ulceration is less than after gastro-enterostomy, but it occurs. Our principal objection is that there is present by these methods the danger of partial obstruction or occasional retrograde filling of the closed loop. If the Scylla of these latter dangers be avoided by the use of entero-anastomosis between the proximal and distal loops of the jejunum, one courts disaster from the Charybdis of secondary jejunal ulceration.

These dangers may be avoided by direct union of the remaining portion of the stomach to the duodenum. This is the principle of the Billroth I. It will be remembered that the Billroth I operation was found to entail what seemed, at the time, too difficult technique, *i.e.*, the union of three lines of sutures, and it was to circumvent this danger that Kocher recommended his method of gastro-duodenostomy, and that in addition to other considerations, led Billroth to advocate his second method. This technical difficulty, however, has, we believe, been solved both by Haberer, who published his results in 1922, and by the speaker, whose report followed independently in 1923. These operators, by thorough mobilization of the duodenum, found that an end-to-side gastro-duodenostomy could be performed in nearly all cases of extensive resections. One may even use this method for a total gastric resection, uniting the cardia to the side of the duodenum. This union is a decidedly more physiological reconstruction than the Billroth II and its modifications, and is to be advised in all cases where sufficient duodenal mobilization can be accomplished to avoid suture strain.

We feel very strongly that an operator should not attempt to force the performance of any one particular type of operation in dealing with gastric or duodenal ulcer. Perforated ulcers should be closed or excised. When located at the pylorus or on the anterior wall near the pylorus, excision may be combined with pyloroplasty. If pyloroplastic operation is not done, gastro-enterostomy is recommended when the patency of the pylorus is diminished or endangered. Perforations away from the pylorus should be excised or closed, or if the condition of the patient permits more extensive surgery, we should recommend partial gastrectomy.

In dealing with chronic ulcers operated upon in a quiescent stage, we prefer pyloroplasty with excision, or partial gastrectomy followed by the Haberer-Finney modification of the Billroth I operation.

Gastro-enterostomy.—This important operation was first performed September 28th, 1881, by Anton Wölfler, an assistant in Billroth's clinic. The anastomosis was made between the stomach "a finger-breadth above the insertion of the gastro-colic ligament," and "a loop of small intestine." Credit has been given to Nicoladoni for having suggested gastro-enterostomy to Wölfler, but we have been unable to find any authority for this division of credit.

The untoward result of the second operation performed a few days later by Billroth showed the necessity for suturing the proximal loop of intestine to the stomach in such a way as to prevent kinking and consequent occlusion. In 1883 Courvoisier advocated making the anastomosis retrocolic and with either the duodeno-jejunal flexure, or the first portion of the jejunum. Von Hacker in 1885 perfected the method of making the opening in the transverse mesocolon, so that the danger to the circulation of the transverse colon is minimized. A third method was sponsored by Billroth and Brenner, by which the jejunal loop was brought through openings in both the transverse mesocolon and the gastro-colic ligament and sutured on the anterior surface of the stomach. To prevent regurgitation of duodenal contents Kocher made the incision in the stomach perpendicular to the long axis and curved so as to form a valve-like opening. The valuable adjunct of entero-anastomosis between the afferent and efferent loops of intestine was suggested by Braun and Jaboulay. The object of this procedure was to regulate the conditions of poor circulation in the loops of intestine thus sutured together in such a way that outflow of the contents of the stomach and intestine is assured. This procedure, performed after any gastro-jejunal anastomosis which entails long afferent and efferent loops, has much to recommend it.

Posterior gastro-enterostomy was improved by von Hacker in 1885, Czerny in 1890, and later brought to its present form by the Mayos, Moynihan, and others. To no other operation have there been suggested more modifications than to gastro-enteros-

tomy. These modifications have had to do with the position of application of the jejunal loop, the length, shape and position of the stoma, and the methods of suture. The introduction of the Murphy button gave a decided impetus to gastro-intestinal surgery. It has certain advantages as well as obvious disadvantages. We would not recommend its use as a routine procedure, but occasions may undoubtedly arise in which its use is indicated, although the speaker has never had occasion to use it. It is frequently used by the French (Pauchet), for entero-anastomosis, when speed is essential.

Billroth I: Haberer-Finney Modification.—In our hands this procedure has been the logical and inevitable outgrowth of the pyloroplasty operation. It represents an attempt to excise the more inaccessible ulcers in the vicinity of the pylorus, particularly those located posteriorly, and to restore continuity by a form of gastro-duodenal anastomosis which embodies the best features of the pyloroplasty. Some of our more difficult and extensive pyloroplasties with excision, particularly when the ulcer was posterior, suggested that the whole procedure would be much simplified by a pylorectomy, which could be followed by a gastro-duodenostomy, using the entire orifice of the stomach and implanting it into the side of the duodenum whose open end has been closed in the usual manner. This anastomosis is practically our pyloroplasty closure, with the exception that the upper curve of the horseshoe incision has been eliminated by the pylorectomy.

We have repeatedly emphasized our firm conviction that the future great advance in surgery of the stomach will depend largely on the utilization of the principles of mobilization of the stomach and duodenum. Pyloroplasty is to a large extent based on this mobilization, and even more so is this method of gastro-duodenostomy.

In this procedure the pyloric end of the stomach is resected in the usual fashion. The stomach is mobilized in the manner suggested by W. J. Mayo and its open end guarded with a clamp which is allowed to remain in place while the duodenum is prepared. The duodenal stump is closed by whatever method is preferred. We prefer a pursestring suture of silk re-inforced by a number of mattress sutures. Then throughout almost its entire length the duodenum is freely and thoroughly mobilized

by the procedure described above. It will be found that this mobilized duodenum may be turned medianward, and that the orifice of the remaining portion of the stomach may be sutured to the side of the duodenum in exactly the same manner in which a termino-lateral gastro-jejunal anastomosis is made. The closed end of the duodenum lies just above the lesser curvature. It should be placed far enough above the orifice of the stomach so that the inverted end presents no possibility of obstructing the orifice; but not so far that there may be a closed loop.

The duodenum and the open end of the stomach are then united by any form of suture desired. The incision in the wall of the duodenum is made to correspond in length to the diameter of the stomach. If the latter is too large, it may be made smaller by closing as much of the stomach as may be desirable, in the manner advocated by Crile. This step is much the same as the treatment of the stomach end in the typical Billroth I.

After having performed this operation several times, we were interested to find that von Haberer, in Innsbruck, had been using the same method, which he had reported in 1922. Our report was made a year later.

The operation has many advantages as contrasted with the Billroth II and its modifications. Gastric contents are received into the duodenum; there is no danger of retrograde filling of a closed duodenal loop or of a partial proximal duodenal obstruction. The transverse mesocolon is not interfered with nor is there any necessity for an ante-colic anastomosis. The chances of post-operative secondary ulceration are greatly diminished. We have encountered none.

It should be constantly borne in mind that the success of the operation depends wholly upon the satisfactory mobilization of the duodenum. If this mobilization is incomplete, suture strain with its disastrous consequences is inevitable. In certain cases satisfactory mobilization has permitted the use of this method after complete gastrectomy.

To summarize: Since the cause of ulcer is unknown and since its presence is a menace to the comfort and happiness, as well as to the life of the individual, who through its presence, is constantly exposed to the dangers of perforation, hemorrhage, etc., it would appear that resection of the ulcer would be indicated.

This, of course, is no guarantee that it might not recur later. It would appear also that that form of surgical procedure which disturbed least the normal physiological relationship of the stomach, other things being equal, would be the method of choice. Beginning with these two general propositions, therefore, pyloroplasty or gastro-duodenostomy, associated, where possible, with resection of the ulcer, would be the procedure of choice. The particular method of accomplishing this would be determined by the conditions present at operation. The acceptance of these general propositions would relegate to second or third choice the operation of gastro-enterostomy, or extensive gastric resection. I am quite aware that this position is not that held by the majority perhaps of general surgeons, but our experience with all types of operations upon the stomach and duodenum has convinced us that, in our hands at least, the best results, both immediate and late, are secured by the use of these methods. Where for any reason more or less extensive resection of the pyloric portion of the stomach is indicated, gastro-duodenostomy by the Haberer-Finney method, where practicable, is the operation of choice. Extensive resection of the stomach is reserved almost entirely for malignant disease. We are not convinced that the sacrifice of large portions of the stomach wall, interfering as this does with both motor and secretory functions of the stomach, is justifiable as a routine procedure. While in the hands of certain surgeons of skill and experience the results reported have been gratifying, still, in the hands of the average surgeon, the risks of such procedures would appear to contra-indicate their general use.

More important perhaps than almost anything else is the mental attitude of the surgeon in approaching an operation. It is a serious handicap to start in to operate with a fixed determination to do a certain form of operation, no matter what the conditions may prove to be. It is bad judgment and worse surgery to attempt to push any operative procedure beyond its natural limitation. One but courts disaster in so doing. The open mind should be the mind of the surgeon. First to establish the facts, then to employ the particular operation that in his judgment is best adapted to the particular circumstances found. In this way his safety and the best end result.